Introduction and Background

Chapter 1

Management of nuclear materials is a fundamental and enduring responsibility that is essential to meeting the Department's national security, nonproliferation, energy, science, and environmental missions into the distant future. To meet this responsibility, the Department is committed to maintaining a coherent and forward-thinking approach to management of these materials through their entire life cycle, from production to use or disposal.

This Plan is the product of ongoing management initiatives and responds to Section 3172 of the FY 2000 National Defense Authorization Act. Both the Department and Congress share the view that significant additional costs can be saved or avoided by better integrating activities related to the management of nuclear materials. This is particularly important given the substantial cost of these management functions and the need to modernize the nuclear materials management complex.

This Integrated Nuclear Materials Management Plan presents the following information:

- a consolidated account to Congress and the public of the Department's unclassified inventory of nuclear materials,
- a description of how these materials are currently managed,
- an examination of opportunities for achieving greater integration, and
- next steps toward realizing those opportunities.

The Plan both offers a valuable information resource and charts a path toward the Department's goal — the integrated, effective, cradle-to-grave management of nuclear materials. The Department believes that, over time, implementation of the Plan can deliver substantial benefits in cost-savings and efficiencies and that those efficiencies will further reduce radiological and other physical risks and contribute to a more robust nuclear materials complex.

This Plan is not itself a decision document. It does not establish new policies or supersede existing ones. Actions taken pursuant to it will be subject to the decision-making processes established by Departmental requirements and procedures.

As a Report to Congress, the Plan is not being issued for public comment, but the Department welcomes the participation of the public as it implements the Plan's principles. The Department's well-established mechanisms for involving the public in its decision making, including the NEPA process, will facilitate this.

Nuclear Materials Covered by this Plan

The materials covered by this Plan include:

- plutonium,
- uranium,
- spent nuclear fuel (Department-owned), and
- other nuclear materials.

These materials are currently stored in a variety of forms and packagings and range from the purer forms of clean plutonium metal to a variety of impure forms such as scrap, residues, and solutions. They also include a variety of isotopes, sources, and so-called "orphan" materials.

The scope of this Plan has been broadened beyond fissile materials, which the congressional request addressed. The Department believes that its entire nuclear materials inventory must be considered as an integrated whole. Low-level, transuranic, and high-level waste streams, although large in volume, are not covered in this Plan, but they are addressed in the Department's EM program plans.

How this Plan is Organized

The remainder of Chapter l provides a brief background on the history of the Department's nuclear materials management, addresses key considerations that guide its efforts, and describes nuclear materials management responsibilities across Departmental programs. Chapter 2 discusses the current approach to managing nuclear materials (the baseline program). Chapter 3 describes the opportunities for organizational and policy improvements and operational improvements that will promote integration, cost savings, or cost avoidances. Chapter 4 recaps the current state of the Department's nuclear materials management program and looks ahead to the Department's agenda for organizational and policy change and improving operations.

Background

Decades of weapons production – the legacy

From 1943 to 1989, the nuclear weapons complex produced and processed tons of unique materials. The complex grew to comprise over 2 million acres of land (an area approximately the size of the States of Rhode Island and Delaware combined) and 120 million square feet of buildings located at 17 major sites, dwarfing the size of most Fortune 500 corporations. Some idea of the scale of this enterprise can be understood from the cost.

From the Manhattan Project through 1995, the United States has spent approximately $300 billion (escalated to FY 1995 constant dollars) on nuclear weapons research, production, and testing. During half a century of operations, the complex manufactured tens of thousands of nuclear warheads and employed hundreds of thousands of workers.

The knowledge and resources gained from weapons production activities also benefited peaceful uses of atomic energy, such as civilian nuclear power and isotope production for medical, agricultural, and industrial applications.

Nuclear materials production started with mined and milled uranium. Uranium was enriched into U-235 either for direct use in nuclear weapons or to produce plutonium for the same purpose. Plutonium was produced by using U-235 as a fuel to produce neutrons to irradiate uranium-238 (U-238) in reactors. In some cases, the U-238 was contained in separate targets. These materials were then chemically processed to recover recyclable uranium and to extract plutonium. Tritium gas, used to boost the explosive power of most modern nuclear weapons, was produced by irradiating lithium targets and then extracting the tritium.

In the late 1980's and early 1990's, growing concerns about environmental and safety issues caused the Department to temporarily suspend various operations throughout the weapons complex. Many of these temporary shutdowns became permanent with the end of the Cold War and the collapse of the Soviet Union. However, the Department had not made long-term storage or disposition plans for the "in-process" nuclear materials prior to suspending operations. Safely managing these materials is an important national challenge.

Appendix I provides a more detailed history of U.S. nuclear materials production.

Planning for legacy cleanup and waste disposition

The Department has given high priority over the past several years to the accelerated cleanup and closure of sites and the disposition of nuclear materials and waste. Key planning efforts, which are documented in the Department's Baseline Environmental Management Report (DOE, 1996g) and "Accelerating Cleanup: Paths to Closure" (DOE, 1998c), significantly furthered Departmental progress in defining the scope, schedules, and life-cycle costs to meet cleanup objectives. The Department's vision, as stated in the Paths to Closure document, is to complete cleanup at most of its 113 sites by 2006.

As part of continuing planning efforts to accomplish this vision, the Department has developed critical closure paths and timetables for closure activities and progress has been made in identifying waste and nuclear materials inventories, determining disposition paths, and evaluating opportunities for program improvements and cost avoidances. Several major NEPA analyses and Records of Decision have been completed that determine the disposition path for surplus plutonium and surplus HEU. Other decisions have been made under NEPA regarding stabilization efforts for materials such as DU and at-risk spent nuclear fuel and target materials to resolve near-term storage vulnerabilities and prepare the materials for disposition. These decisions, and other current activities and plans, are discussed further in Chapter 2.

Changing Departmental missions

With the end of the Cold War and after nearly 50 years of large-scale nuclear materials production and research focused primarily on nuclear weapons, the Department's mission has changed in nature and scope. The nuclear weapons complex has ceased weapons-capable material production, since national security and strategic reserve materials in the stockpile are sufficient at this time to meet defense needs. However, the Department has production requirements to replenish its tritium stockpile and to generate specialized isotopes for research and development and medical and commercial applications.

The Department must meet its future national security, non-proliferation, nuclear energy, and science requirements, even as it simultaneously: (1) "right sizes" the nuclear weapons complex; (2) plans the disposition of a large and diverse inventory of surplus materials; and (3) continues to mitigate environmental safety and health issues that result from the legacy of 50 years of materials production.

Following are the seven Departmental mission areas that are most affected by nuclear materials management decisions and the major functional capabilities required for the complex. The Department expects these missions to remain important for the foreseeable future and to drive decisions on the use or disposition of nuclear materials.

Mission Areas that Encompass Nuclear Materials (Today and into the Foreseeable Future)

Nuclear Weapons: Maintain nuclear weapons and the attendant infrastructure necessary for our national defense.

Arms Control: Reduce the worldwide stockpile of nuclear weapons.

Nonproliferation: Prevent the spread of nuclear weapons and reduce weapons-usable fissile material.

Nuclear Energy: Conduct vital research and development; enhance science and technology; provide isotopes for medical, commercial, and research purposes.

Environment: Disposition remaining legacy materials and facilities.

Science: Supply nuclear materials for future scientific and medical research.

Naval Reactors: Provide safe and reliable nuclear propulsion for U.S. Navy ships.

Major Functions

- Enrichment
- Fabrication
- Irradiation
- Separation
- Storage
- Transportation
- Purification
- Down-blending
- Recycling
- Treatment
- Disposal
- Monitoring/Inspections

Key drivers for the management of nuclear materials

A number of key drivers have helped shape the transition from yesterday's Cold War missions to today's management and disposition missions: (1) science-based stockpile stewardship; (2) nonproliferation and national security; (3) surplus materials disposition; and (4) safety issues associated with storage. These are discussed in more detail below.

Science-Based Stockpile Stewardship. Maintaining nuclear weapons without nuclear testing is a technically challenging and unprecedented task. In part, this is because the unique materials in nuclear weapons are aging beyond experience. Through the Science-Based Stockpile Stewardship program, the United States is meeting this challenge. Scientists at the national laboratories are improving their understanding of the fundamental physics and chemistry that govern weapons performance. By careful measurement of the materials that make up a nuclear weapon and by understanding how those materials interact and age, scientists expect to predict changes in safety, reliability, and performance.

Nonproliferation and National Security. There are many treaties and agreements, international commitments, Executive Orders, and legislative actions that drive the nonproliferation and national security program needs with respect to nuclear materials management. U.S. nuclear nonproliferation policy is anchored in certain bedrock principles and actions, which are described and reviewed in annual Administration Reports to Congress pursuant to Section 601 of the Nuclear Nonproliferation Act of 1978, as amended by the Nuclear Proliferation Prevention Act of 1994. These principles include the following:

- Preventing the spread of nuclear explosives to additional countries is a fundamental objective of U.S. national security and foreign policy.
- The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is an indispensable instrument for promoting and maintaining peace among nations.
- Consistent with Article VI of the NPT, the United States is committed to achieving further reductions in U.S. and Russian nuclear arsenals.
- By Administration policy, the provisions of the Comprehensive Test Ban Treaty remain an important constraint on the proliferation of nuclear weapons and development of advanced new types of nuclear weapons.
- The International Atomic Energy Agency (IAEA), with its system of international safeguards on nuclear material, makes a vital contribution to global security.
- Agreements for peaceful nuclear cooperation among the United States and its partners provide an essential framework of conditions and controls for mutually beneficial cooperation in the peaceful uses of nuclear energy.
- Effective nuclear export controls make a major contribution to ensuring that nuclear technology involved in cooperation with other nations is used for peaceful purposes only.
- All countries should maintain: (1) adequate systems of materials accounting and control; and (2) physical protection of nuclear materials.

Some of the key nonproliferation programs, and the nuclear management considerations that arise as a result of these programs, are summarized as follows. Appendix II provides a more extensive discussion of the U.S. nonproliferation commitments.

- **Strategic Arms Reduction Treaty (START) III —** Beginning in FY 2000, the Department leads an interagency task force on warhead and fissile materials to implement a START III concept for warhead elimination. The interagency task force decisions will drive domestic needs for facilities to dispose of pits and transparency measures to confirm that weapons are being dismantled and that excess fissile materials removed from dismantled nuclear

weapons are not reused in the production of new nuclear weapons. The Department maintains a technical dialogue with Russian scientific and technical organizations through the Lab-to-Lab Weapons Dismantlement Transparency efforts. Through this dialogue, U.S. and Russian scientists will jointly develop and evaluate proposed transparency measures.

- **U.S. - Russia Plutonium Disposition Agreement —** The United States is currently negotiating an agreement with Russia on plutonium disposition under which the two countries would proceed to implement parallel programs with comparable rates of plutonium disposition. Substantial progress on this agreement will commit the United States to disposition weapons-capable plutonium using either mixed oxide (MOX) fuel or immobilization as a means to increase proliferation resistance. This agreement is needed before the United States will begin construction of plutonium disposition facilities at SRS.
- **International Plutonium Management Guidelines (INFCIRC-549) —** The United States and eight other plutonium-using countries submitted to the IAEA their acceptance of this unified package of accepted rules for the storage, handling, and transportation of civil plutonium, as well as military plutonium that has been declared as no longer required for defense purposes. Reporting requirements include a formal declaration of national plutonium strategies and an annual declaration of stockpiles of non-military plutonium (with an estimate of plutonium content in spent nuclear fuel).
- **HEU Transparency Implementation Program —** The Department is responsible for ensuring that the nonproliferation aspects of the February 1993 HEU Purchase Agreement between the United States and the Russian Federation are met. Under the Agreement, conversion of the HEU components into LEU is performed in Russian facilities. The program permits the United States to have confidence that the Russian side is abiding by the Agreement and requires the United States to support comparable monitoring activities by Russian Federation representatives at U.S. facilities subject to the Agreement. Key features of transparency measures currently include regular visits to all facilities that process uranium subject to the Agreement, plus permanent monitoring presence at the Ural Electrochemical Integrated Enterprise in Russia and at the Portsmouth Gaseous Diffusion Plant in the United States. DOE coordinates its HEU Transparency Implementation operations with the Department of State.
- **The U.S.-Russia-IAEA Trilateral Initiative —** The Initiative is aimed at increasing international verification of weapons-usable materials in the two states, to confirm that fissile materials no longer needed for defense purposes are not reused to produce nuclear weapons. A trilateral working group has been negotiating the legal and technical aspects of the initiative, which will drive requirements for transparency, monitoring needs, and managed access at both U.S. and Russian facilities.
- **Fissile Material Cut-Off Treaty (FMCT) —** The Department continues to support the U.S. Government-led negotiations on the FMCT and will provide implementation-related analytical and technical support. The Department will conduct domestic and international exercises and/or multilateral verification workshops and site visits to assess monitoring impacts and requirements. The Department also will conduct multi-agency cooperative assessments, on-site inspection simulations, and complex data surveys to support the compilation of treaty and agreement-mandated declaration submissions. Further, these activities may be conducted to support bilateral agreements that may be negotiated with individual countries to monitor the production of weapons-usable nuclear material.
- **IAEA Strengthened Safeguards Program —** The United States is committed to supporting the IAEA Strengthened Safeguards Program. This program allows for international inspectors on all sites associated with nuclear programs, including those involved in national security programs, and environmental sampling at those sites. There will be a need for new approaches to managed access at sensitive Departmental facilities under this program, as well as an opportunity to lead the international community in technical implementation.

Surplus Materials Disposition. The driving force for disposition of surplus nuclear weapons-capable fissile materials is to reduce the threat of nuclear weapons proliferation worldwide. Comprehensive disposition actions are needed to ensure that surplus materials are converted to proliferation resistant forms. In September 1993, President Clinton issued the Non-Proliferation and Export Control Policy in response to the growing threat of nuclear proliferation. Further, in January 1994, President Clinton and Russia's President Yeltsin issued a joint statement between the United States and Russia on non-proliferation of weapons of mass destruction and the means of their delivery. In accordance with these policies, the focus of the U.S. nonproliferation efforts includes ensuring the safe, secure, long-term storage and disposition of surplus weapons-capable fissile materials inventories. Disposition activities undertaken by the United States will enhance its credibility and flexibility in negotiations on bilateral and multilateral reductions of these inventories.

Safety Issues Associated with Storage. A top priority is safely managing at-risk nuclear materials and facilities. This is being accomplished through stabilization and repackaging of

materials and improving storage facilities. The DNFSB has played a significant role in identifying safety issues associated with existing storage of materials. Various Departmental environmental, safety, and health vulnerability assessments have also resulted in priority attention to stabilizing and repackaging materials and upgrading or replacing key facilities. Examples include:

- DNFSB Recommendation 94-1 (DNFSB, 1994) identified the need to stabilize and safely store large amounts of fissionable and other nuclear materials. The Board was especially concerned about specific liquids and solids in spent fuel storage pools, reactor basins, reprocessing canyons, processing lines, and various other defense facilities remaining in the manufacturing pipeline when pit production at Rocky Flats was terminated in 1989. The Department has moved to remediate these safety vulnerabilities, as documented in its Implementation Plan (DOE, 1995f and revisions 1998b and 2000b).
- In January 2000, the DNFSB issued Recommendation 2000-1 (DNFSB, 2000) as a followup to its 94-1 Recommendation. While a great deal has been accomplished in meeting the safety objectives set forth in Recommendation 94-1, particularly with regard to those materials that constituted the most imminent hazards, the Board is concerned that problems continue to exist and that the implementation of Recommendation 94-1 has taken longer than expected. The Board encouraged the Department to address stabilization of the remaining materials with more urgency. Remaining problems cited by Recommendation 2000-1 are highlighted in the text box to the left.
- Other DNFSB safety recommendations have dealt with conditions of U-233, plutonium pit storage, safety management at the Pantex Plant, and criticality safety (DNFSB, 1997a, 1997b, 1998, 1999a, and 1999b). The Department has been actively addressing these issues, as well as safety issues identified independently in safety and health vulnerability assessments (DOE, 1993, 1994, and 1996e). The current baseline activities and plans described in Chapter 2 include actions to address these various safety recommendations.

DNFSB Recommendation 2000-1

- Stabilize uranium solutions outside SRS's H Canyon to remove criticality concerns.
- Remediate the americium and curium solutions at SRS's F Canyon and neptunium solutions at H Canyon.
- Convert remaining plutonium solutions to stable oxides or metals and package into welded containers with inert atmospheres.
- Treat plutonium-bearing polycubes at Hanford's Plutonium Finishing Plant to remove and stabilize the plutonium.
- Continue stabilization of spent nuclear fuel at SRS.
- Stabilize and seal within welded containers with an inert atmosphere the plutonium oxides produced at various defense facilities and those which do not conform to the Department's standard for long-term storage (DOE, 1999k).
- Enclose legacy plutonium metal in sealed containers with an inert atmosphere.
- Remediate and/or safely store various residues at the three production sites and two of the national laboratories.

Organizational Responsibilities

Departmental program offices implement the various missions and other responsibilities described above. Through the program offices, the Department also undertakes nuclear materials stabilization, waste management, science research, technology development, and other functions associated with its missions.

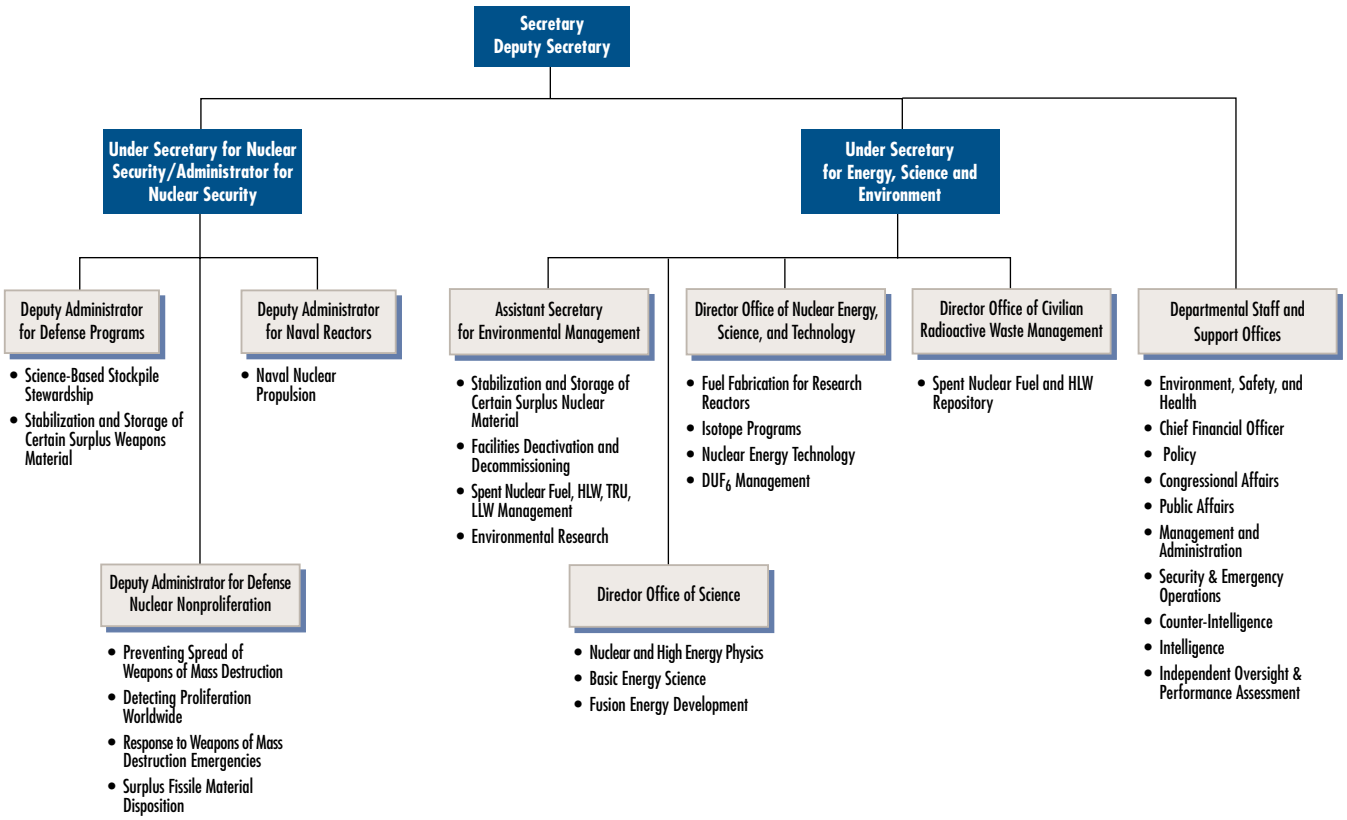
Figure 1-1 displays the Department's organizational structure for implementing its nuclear material management missions. The complete Departmental organization chart is provided in Appendix III. Programs with line responsibility for managing nuclear materials are as follows:

National Nuclear Security Administration (NNSA) — The new NNSA brings together those organizations having direct responsibility for maintaining the nation's nuclear weapons arsenal, as well as planning for and completing the disposition of surplus fissile materials. The NNSA also provides policy and technical assistance to curb global proliferation of weapons of mass destruction, emphasizing U.S. nuclear nonproliferation, arms control, and nuclear safety objectives.

Office of Defense Programs (DP) — DP provides an infrastructure and the intellectual capability to maintain the nuclear weapons stockpile, including replacing limited life components and ensuring an adequate supply of tritium. Since 1989, when the production of new warheads was stopped at Rocky Flats, the primary focus of DP has shifted from weapons production to stockpile life extension and surveillance. DP is now responsible for:

- continuing to maintain the nuclear stockpile, including the strategic inventory of weapons-usable nuclear materials;
- restructuring and modernizing the weapons complex; and

Figure 1-1 Current DOE Functional Structure for Nuclear Materials Management



- retaining the capability to resume nuclear testing and meet production requirements appropriate to future national security needs.

In fulfilling its national security responsibility, DP is required to maintain the vitality of the key nuclear weapons national laboratories: LANL, LLNL, and Sandia National Laboratories (SNL).

Office of Environmental Management (EM) — EM is responsible for the stabilization and storage of certain surplus weapons-capable nuclear materials; treatment and storage of high-level waste and spent nuclear fuel; deactivation, decontamination, and decommissioning of excess facilities; disposal of TRU, LLW and mixed low-level waste; waste minimization; and material recovery/reuse. Over the years, EM has accepted custody of substantial quantities of non-waste, surplus nuclear materials. If programmatic uses are identified, they are reassigned to user organizations. EM will otherwise dispose of all remaining nonweapons-capable materials in an efficient manner.

Office of Nuclear Energy, Science and Technology (NE) — This office conducts vital research and development, enhances science and technology, and manages nuclear facilities and materials. NE's responsibilities include:

- utilization, management and disposition of nuclear materials such as natural uranium and DUF_6;
- nuclear fuel element fabrication for research reactors;
- conversion of U.S. university research reactors from HEU to LEU reactor fuel;
- production of Pu-238 for National Aeronautics and Space Administration (NASA) missions (currently under NEPA review); and
- medical, industrial, and research isotope production and distribution.

Office of Defense Nuclear Nonproliferation (NN) — NN is the lead office for activities and programs that support U.S. arms control and nonproliferation policies, goals, and objectives, as well as statutorily mandated activities. The office provides leadership and representation for the Department in the international arms control and nonproliferation community and the U.S. Government's interagency process, as well as for the U.S. Government in national and international arms control and

nonproliferation negotiations, agreements, and interactions. NN is also responsible within the Department for technology development and program implementation to prevent the proliferation of nuclear weapons, detect nuclear proliferation, and monitor nonproliferation and arms control treaties and agreements.

Office of Fissile Materials Disposition (NN-60) - The Office of Fissile Materials Disposition reports to the Office of Defense Nuclear Nonproliferation as of March 1, 2000, as part of the NNSA reorganization. For purposes of this report, the Office of Fissile Materials Disposition will be designated as MD. The principal objective of the Office of Fissile Materials Disposition is the disposition of substantial inventories of surplus U.S. weapons-usable plutonium and HEU and providing technical support for reciprocal actions by Russia for the disposition of its surplus weapons plutonium. MD is working with Russia to conduct joint tests and demonstrations of plutonium disposition technologies.

Office of Naval Reactors (NR) — Executive Order 12344, as set forth in Public Law 106-65, stipulates responsibilities and authority of the Naval Nuclear Propulsion Program, of which the Deputy Administrator for Naval Reactors is a part. NR's responsibilities include:

- performing research, development, design, acquisition, construction, inspection, installation, certification, testing, overhaul, refueling, operating practices and procedures, maintenance, supply support, and ultimate disposition of naval nuclear propulsion plants;
- ensuring the safety of reactors and associated naval nuclear propulsion plants and controlling radiation and radioactivity associated with naval nuclear propulsion activities; and
- administering the naval nuclear propulsion program.

Office of Civilian Radioactive Waste Management (RW) — RW is responsible for implementing the Nuclear Waste Policy Act, as amended, for developing a permanent, safe, monitored geologic repository for disposal of spent nuclear fuel from commercial nuclear power plants and for Department-owned spent fuel and HLW.

Office of Science (SC) — SC is responsible for funding the operation of facilities that use non-national security nuclear materials for basic and applied research (e.g., specified non-Department university research and development). SC manages many smaller nuclear materials facilities at research laboratories, and provides non-national security nuclear materials as needed for Department and non-Department programs. SC also evaluates the necessity to acquire, produce, or recover nuclear materials not available from the existing inventory.

The way in which these programs manage nuclear materials within their specific areas of responsibility is reflected in the Department's baseline programs as described in Chapter 2.